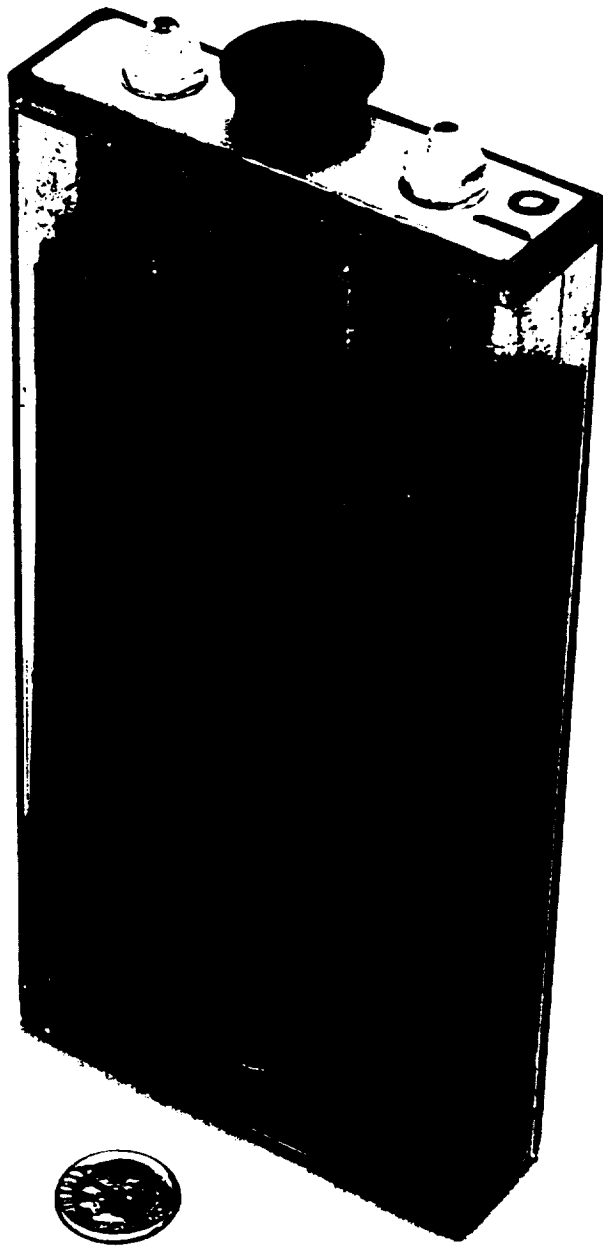


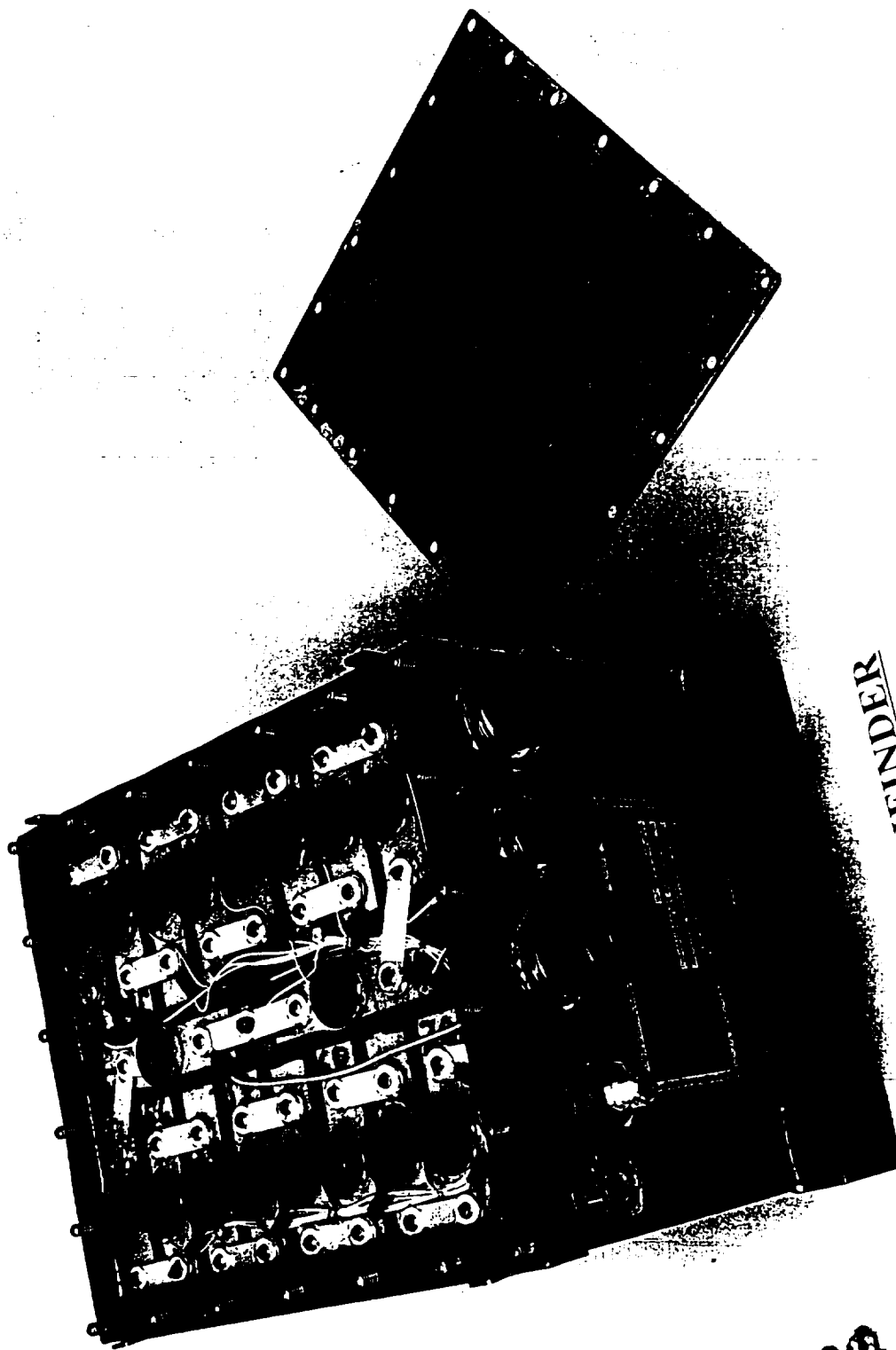
JPL Experience With The
Mars Pathfinder, Mission Simulation Battery

NASA Battery Workshop
December 3, 4, and 5 1996
Huntsville, Alabama

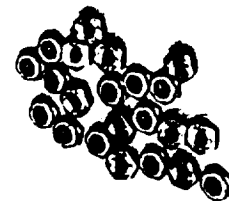
Dave Perrone and Richard Ewell
Jet Propulsion Laboratory

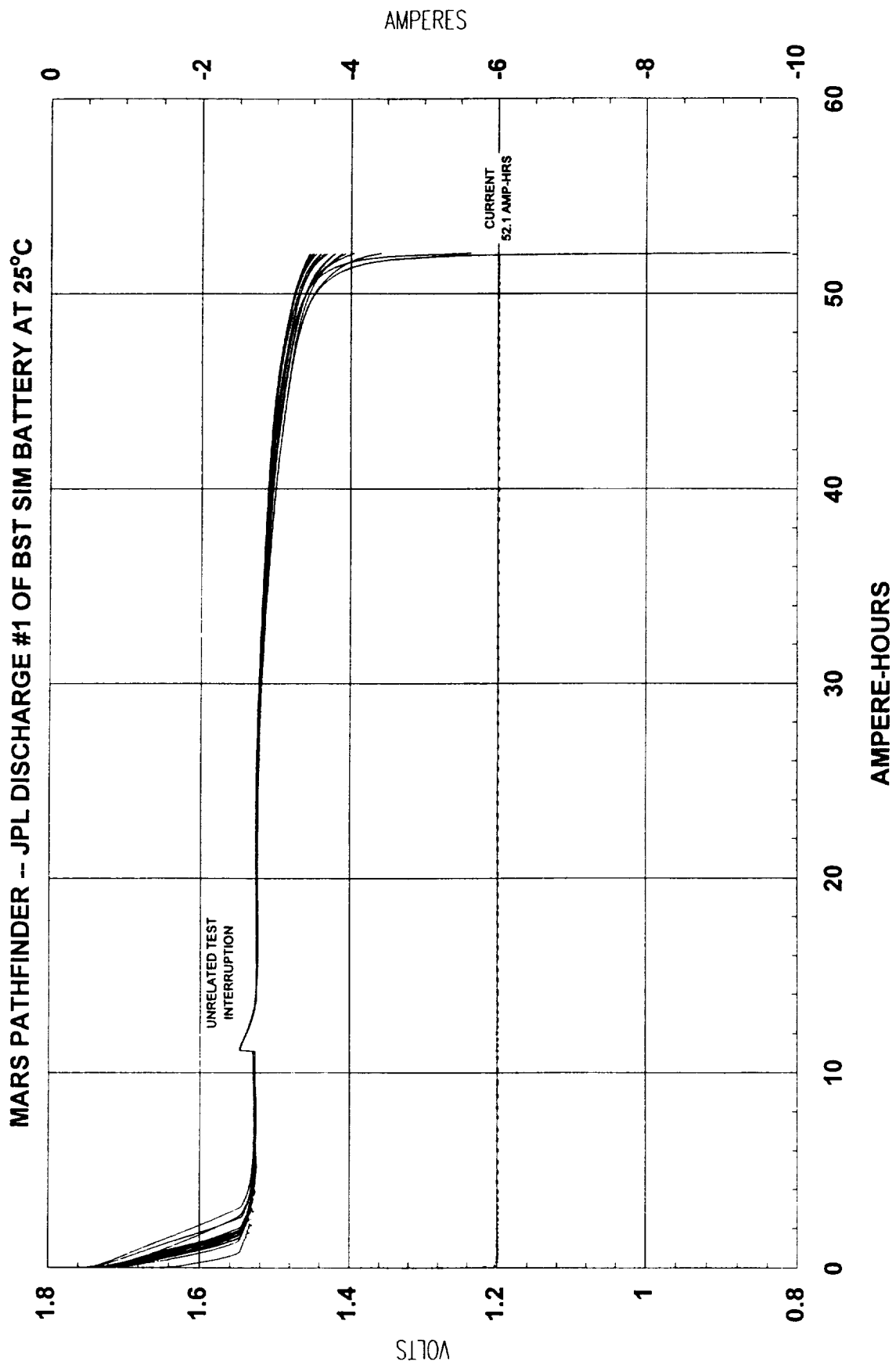
54-44





MARS PATHFINDER
18 cell, 40 Ampere-hour, Ag-Zn battery



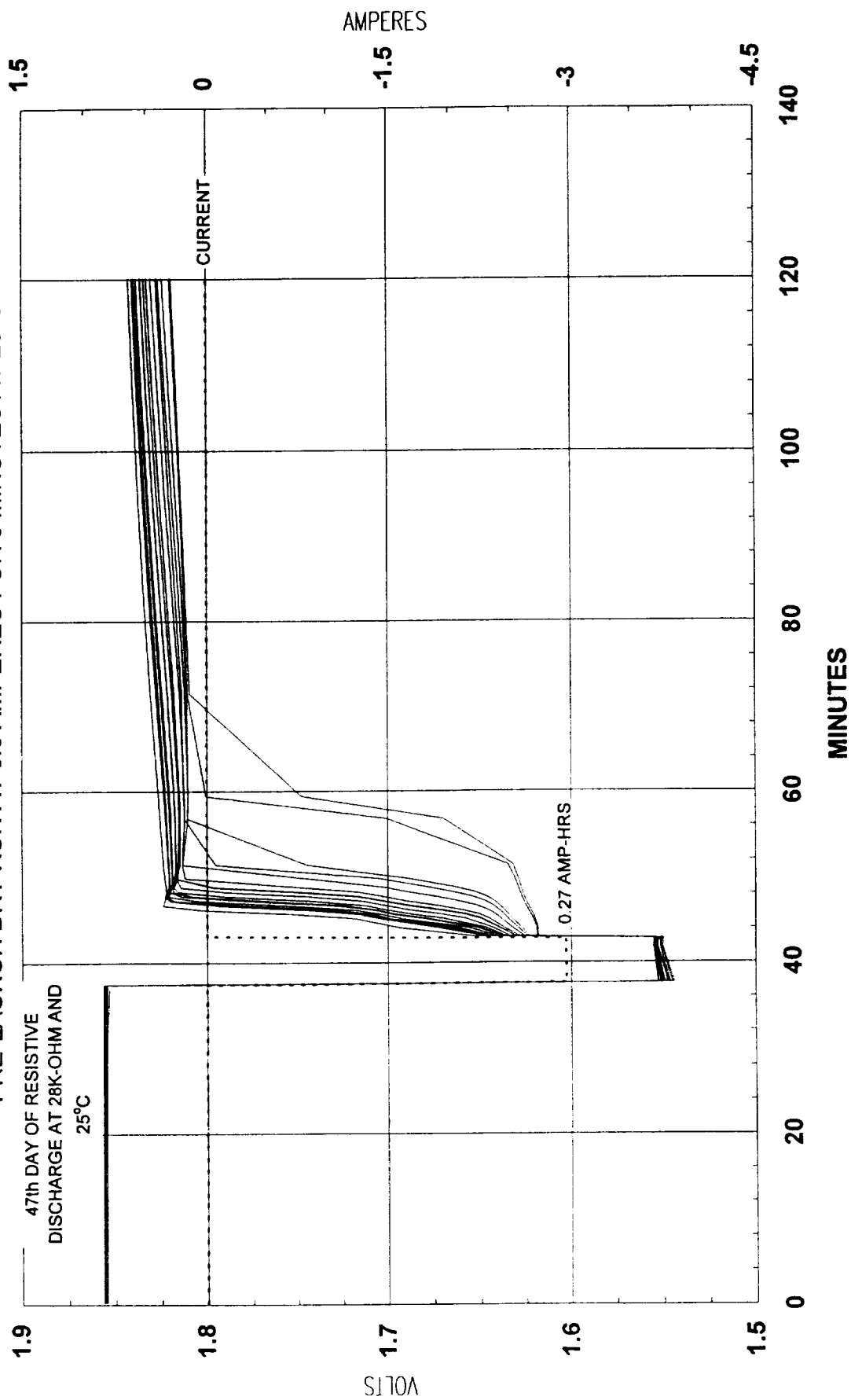


Mars Pathfinder Battery - Expected Mission Profile

- **4 months discharge at 1 to 2 mA**
 - battery is inverted for duration
 - ambient temperature at 15°C
- **Launch**
 - battery remains inverted
 - 4.2A for 81 minutes
 - 6.0A for 50 minutes
- **Cruise**
 - ambient temperature from 10° to -5°C
 - stand in a partial state of charge (~ 40 ampere-hours)
- **Entry, Descent, and Landing**
 - 40 Ampere-hours
- **Mars Surface Operation**
 - 30 cycles at 50% depth of discharge

MARS PATHFINDER -- BST 18 CELL Ag-Zn SIMULATION BATTERY (INVERTED)

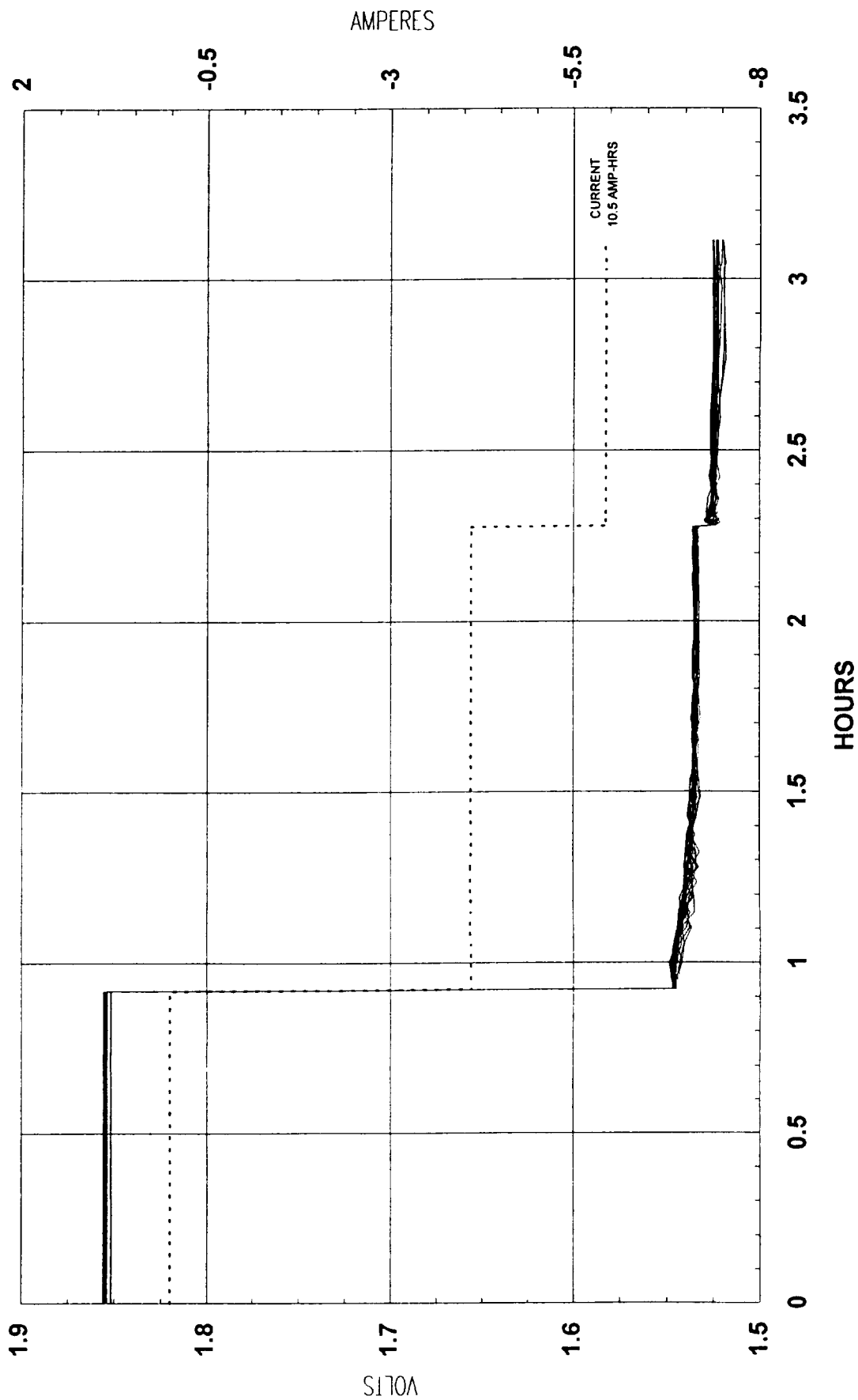
PRE-LAUNCH DRY RUN AT 3.0 AMPERES FOR 5 MINUTES AT 25°C



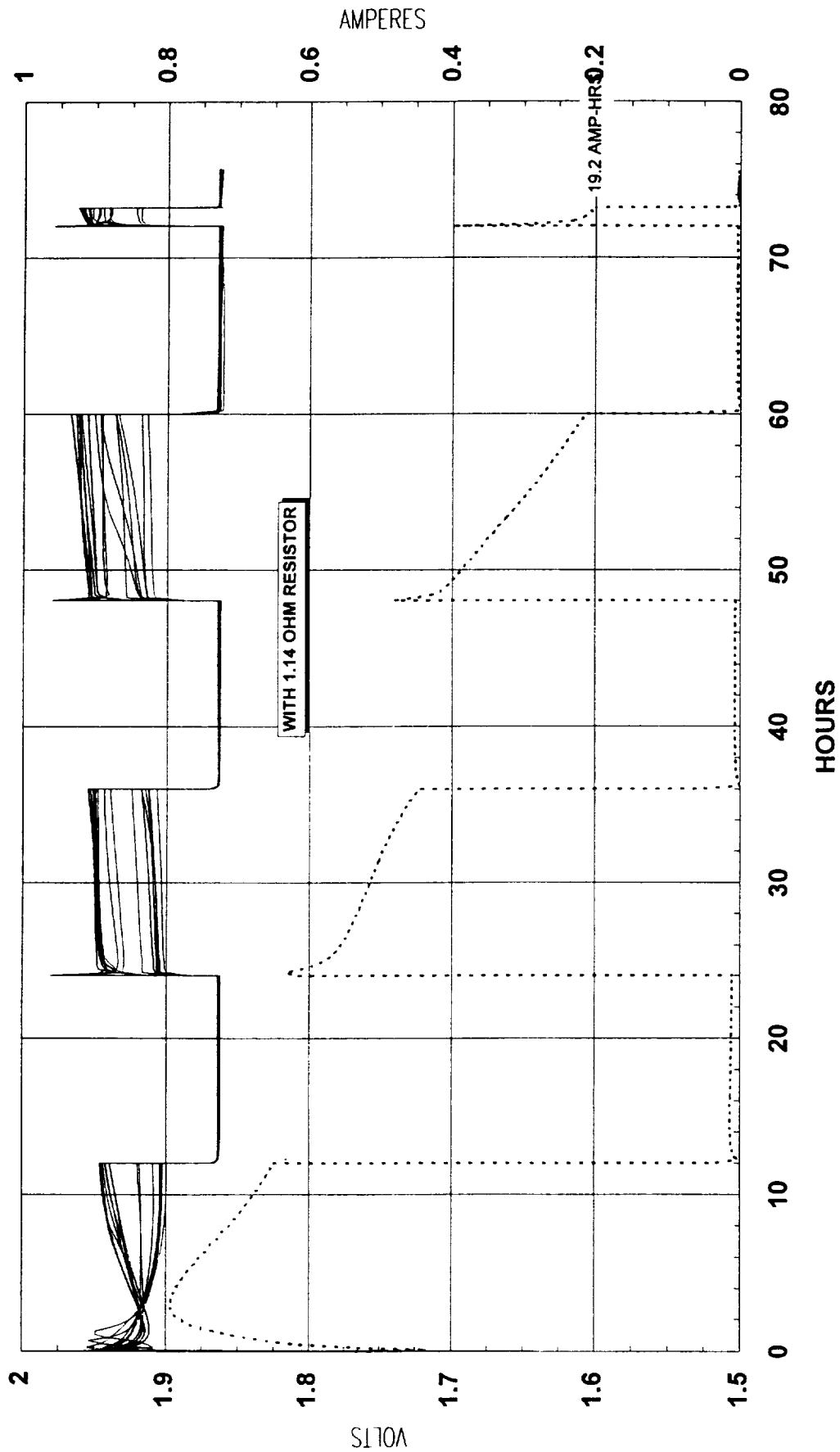
D. PERRONE 12/5/96 3:46 PM

MARS PATHFINDER -- BST 18 CELL Ag-Zn SIMULATION BATTERY (INVERTED)

LAUNCH AT 4.15A FOR 81 MINUTES THEN AT 6.0A FOR 50 MINUTES AT 25 THEN 15°C AMBIENT

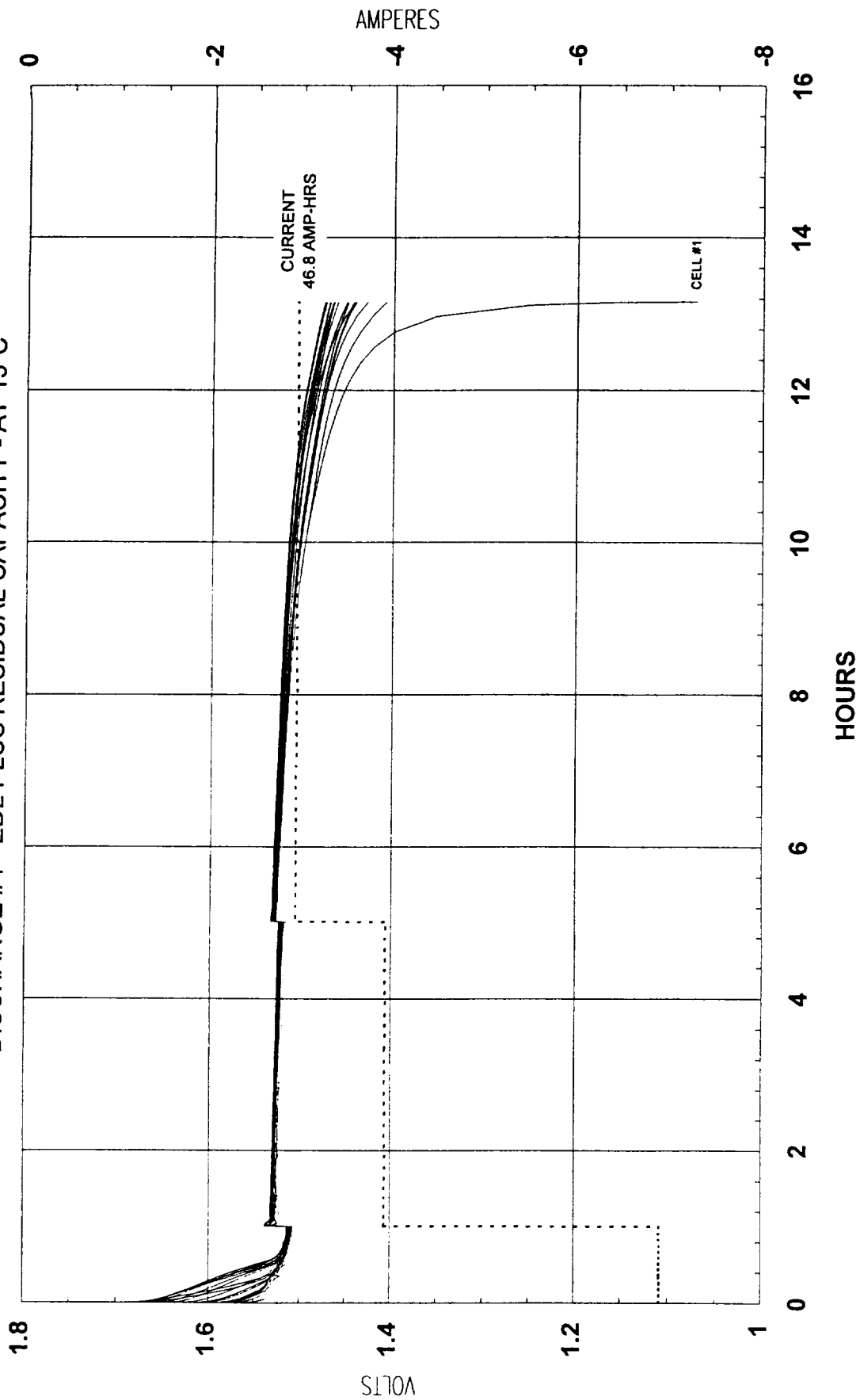


MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY
CHARGE #4 FOR 12 HOURS AT 1.960 VPC THEN 12 HOURS AT 1.860 VPC AT 25°C
FOLLOWS 7 MONTHS WITH 28KOHM RESISTIVE LOAD



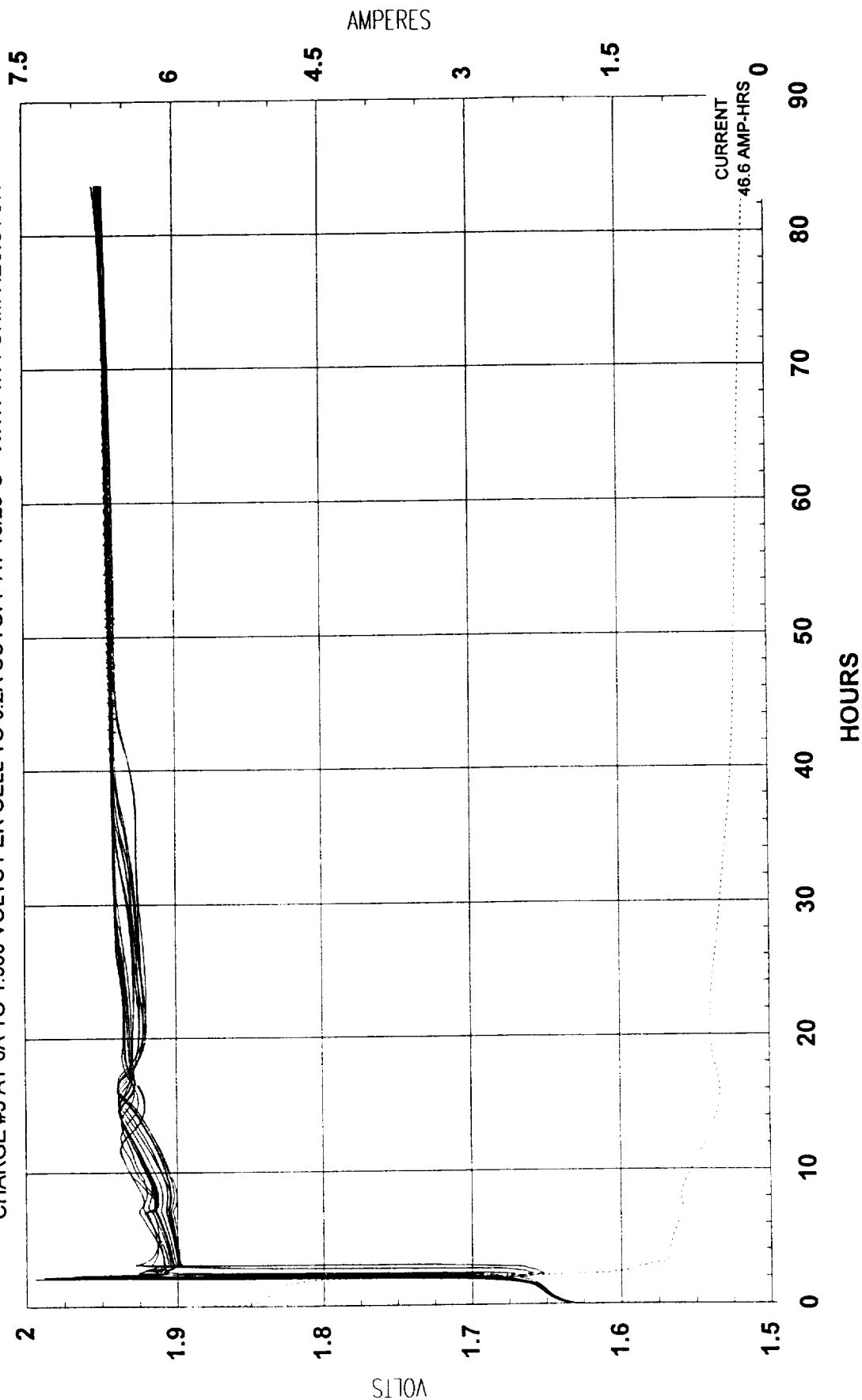
MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY

DISCHARGE #4 - EDL PLUS RESIDUAL CAPACITY - AT 15°C



D. PERRONE 12/5/96 3:47 PM

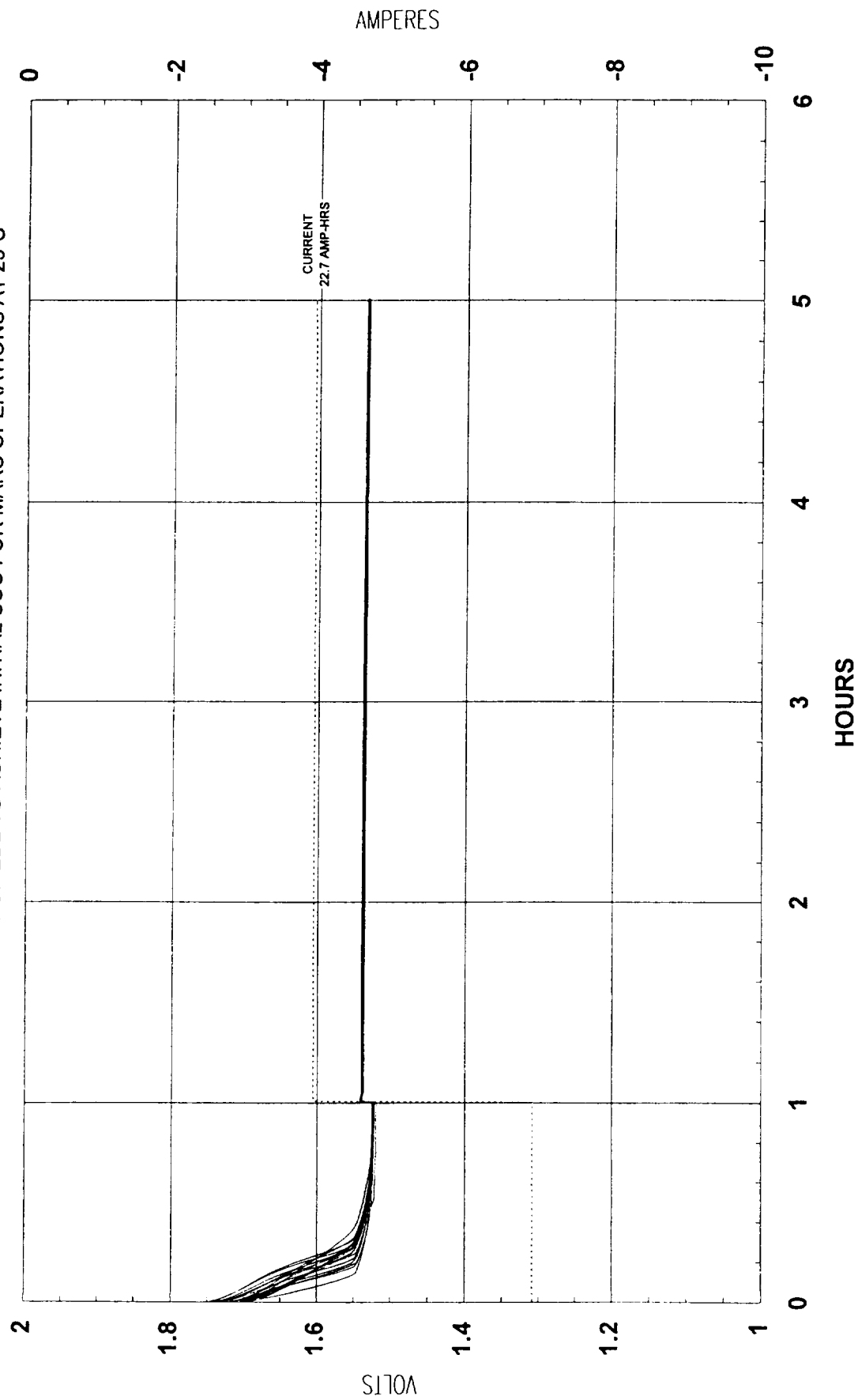
MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY
CHARGE #5 AT 8A TO 1.960 VOLTS PER CELL TO 0.2A CUTOFF AT 15/25°C - WITH 1.14 OHM RESISTOR



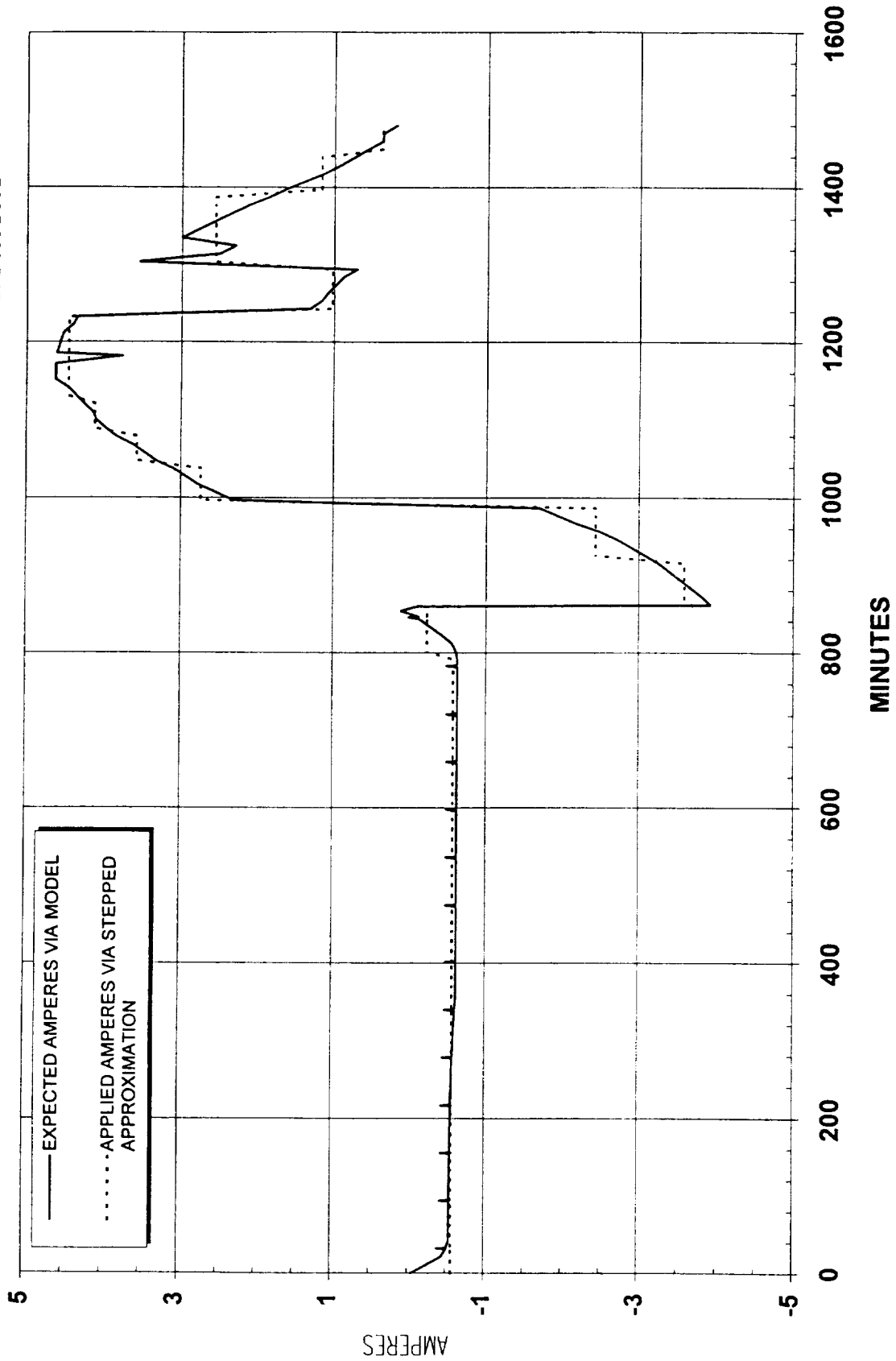
D. PERRONE 12/5/98 3:47 PM

MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY

DISCHARGE #5 - REPEAT OF EDL TO ACHIEVE INITIAL SOC FOR MARS OPERATIONS AT 25°C

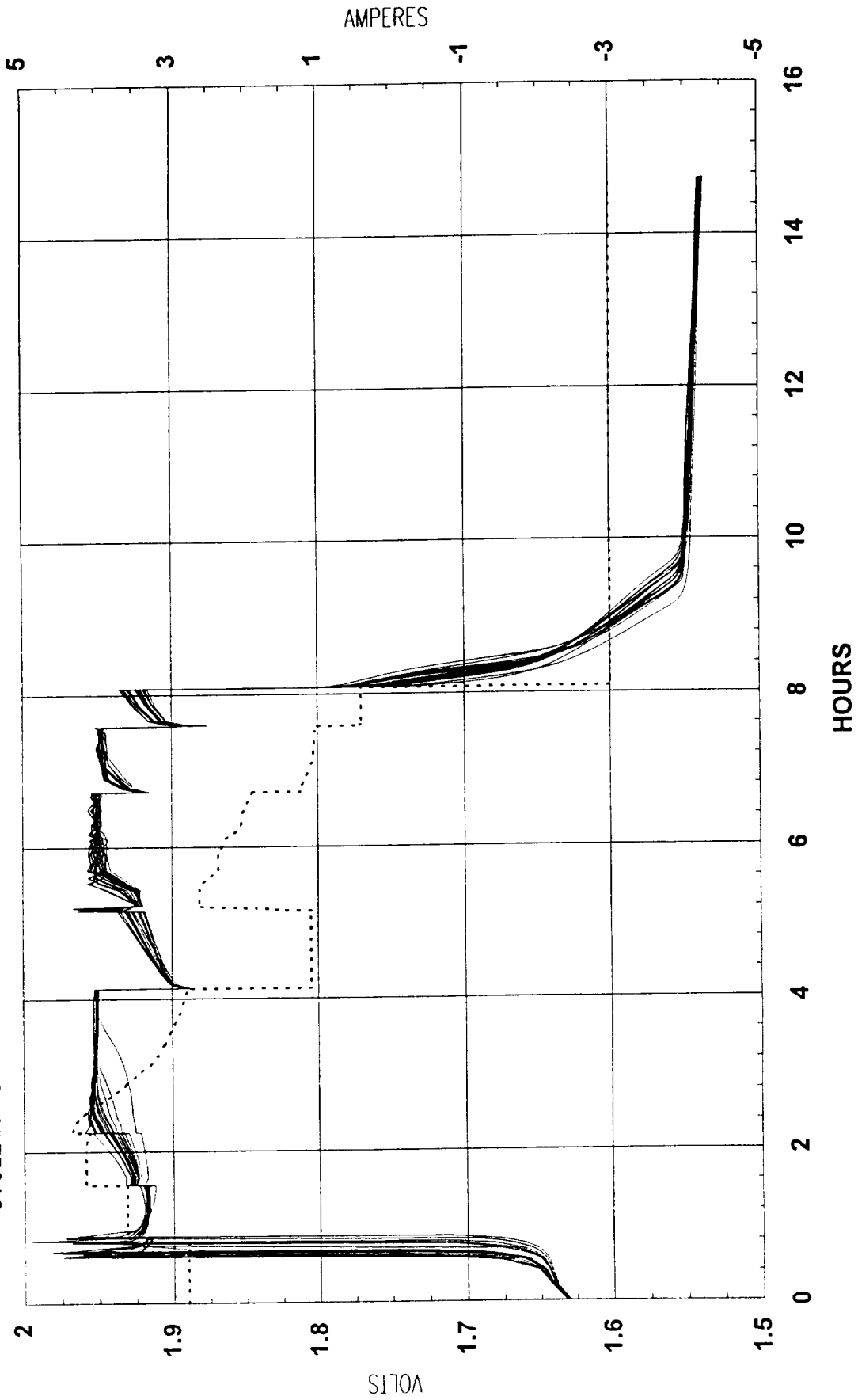


POWER SUBSYSTEM SIMULATION FOR STEADY STATE MARS OPERATIONS



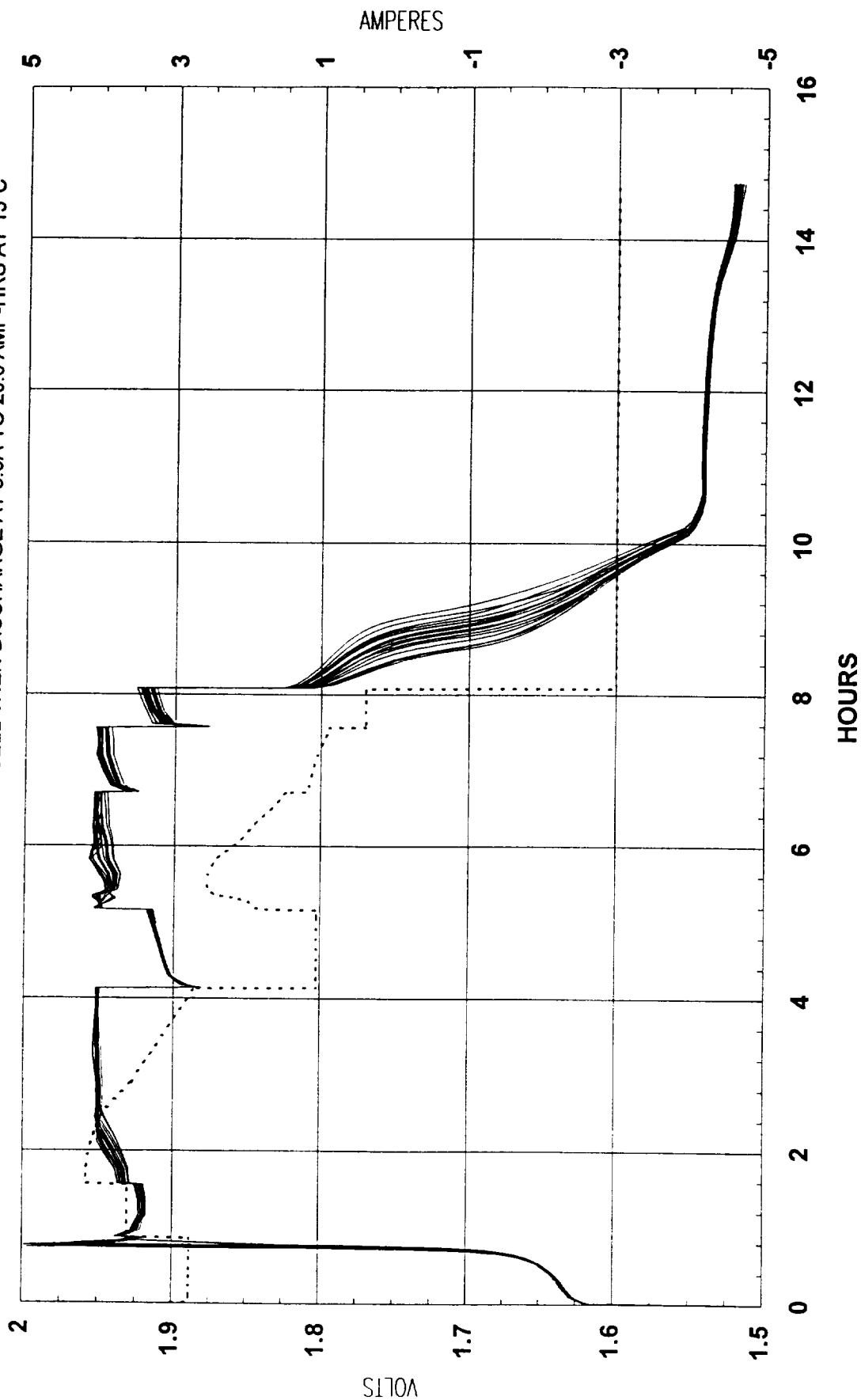
MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY

CYCLE #6 - CHARGE TO 1.950 VOLTS PER CELL THEN DISCHARGE AT 3.0A TO 20.0 AMP-HRS AT 25°C



D. PERRONE 12/5/96 3:49 PM

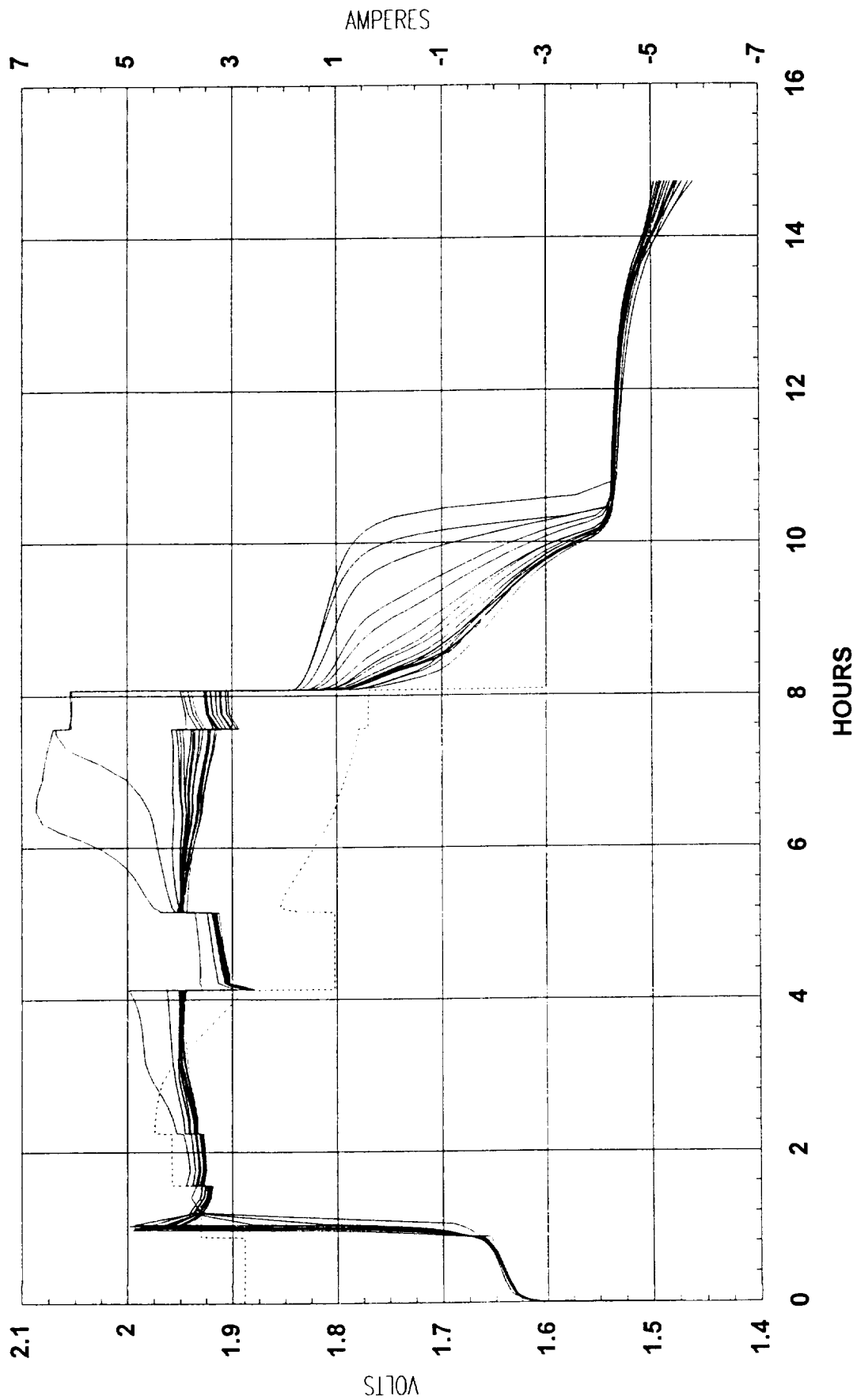
MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY
 CYCLE #14 - CHARGE TO 1.950 VOLTS PER CELL THEN DISCHARGE AT 3.0A TO 20.0 AMP-HRS AT 15°C



D. PERRONE 12/5/96 3:50 PM

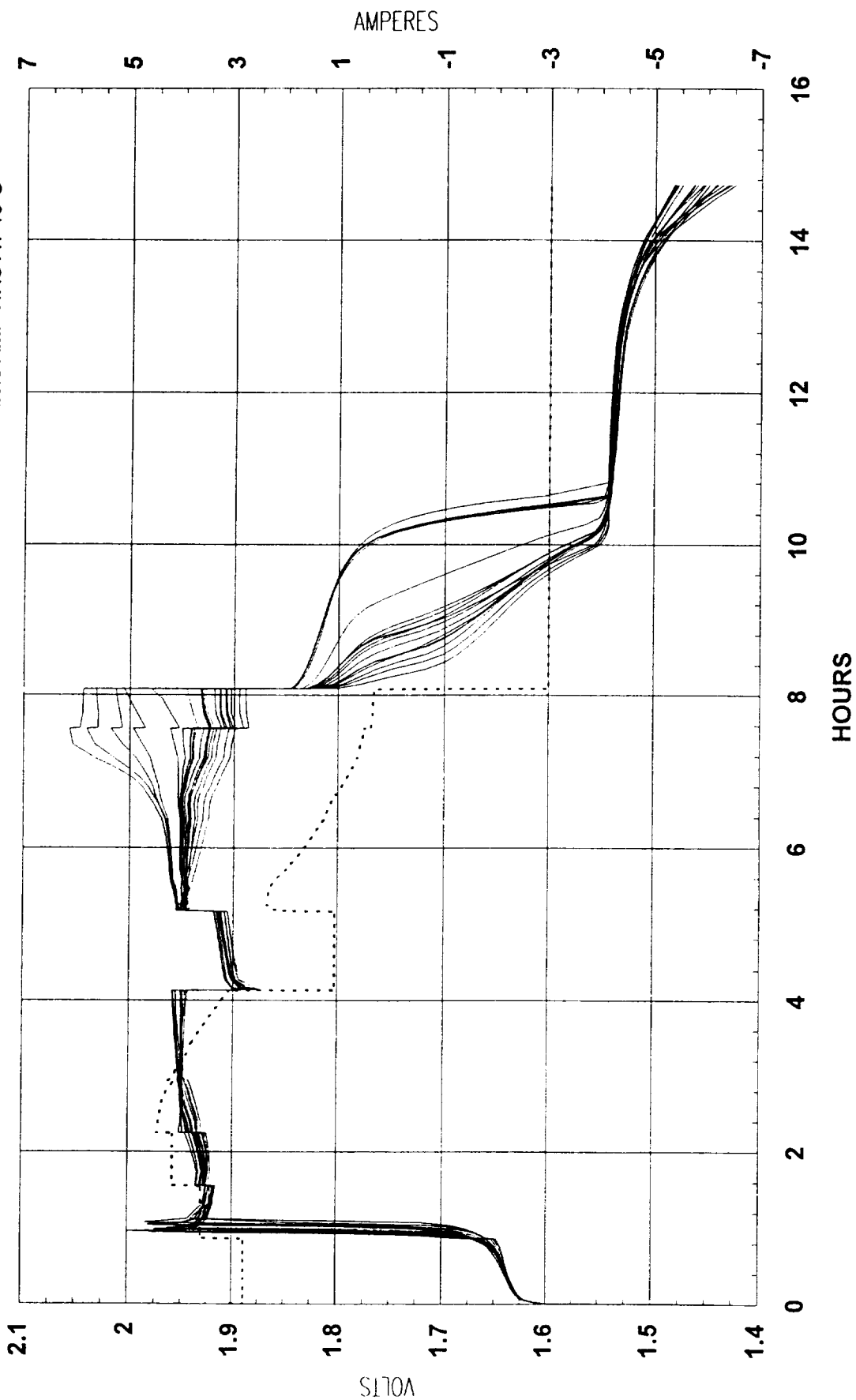
MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY

CYCLE #24 - CHARGE TO 1.950 VOLTS PER CELL THEN DISCHARGE AT 3.0A TO 20.0 AMP-HRS AT 10°C

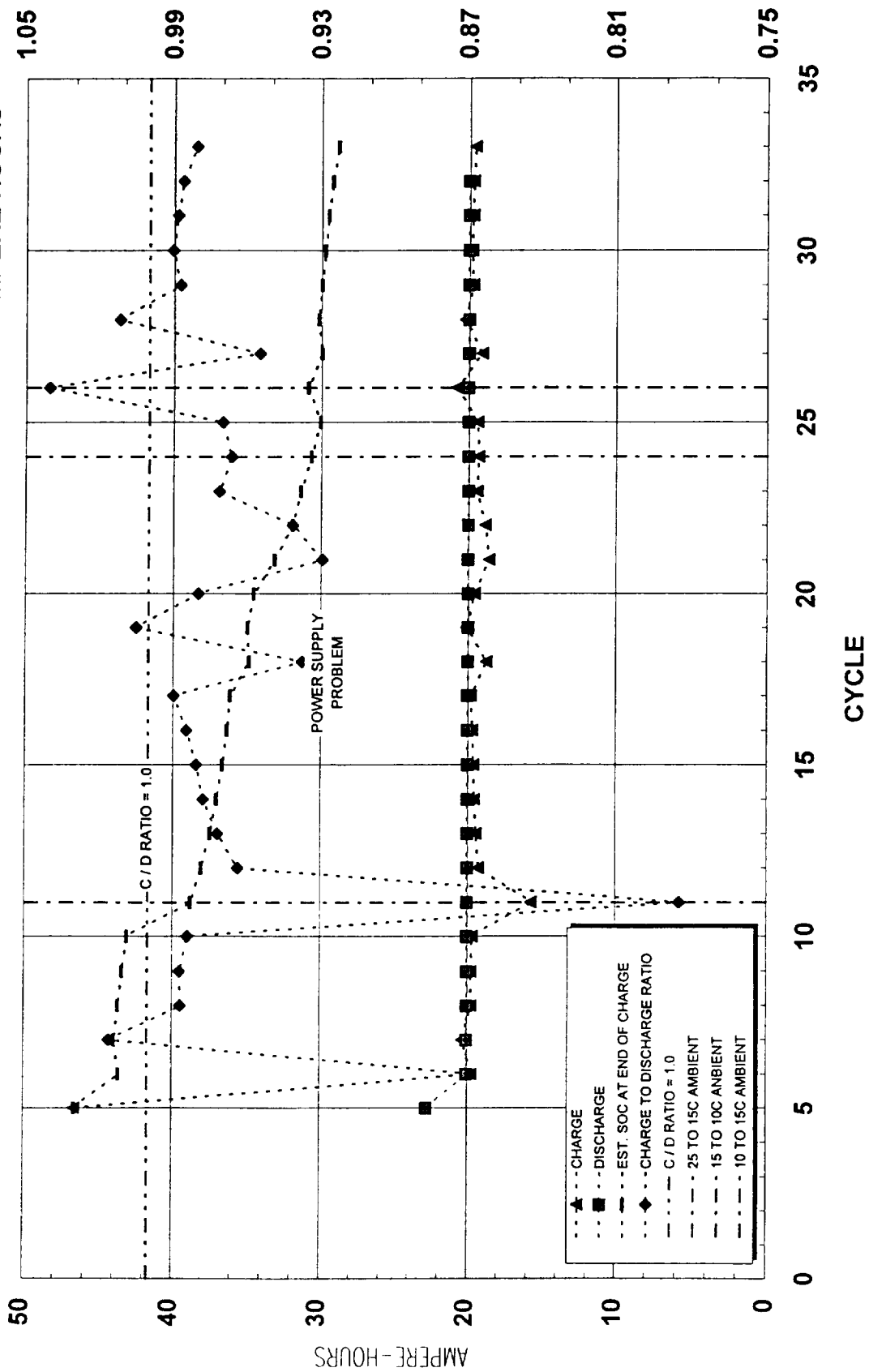


D. PERRONE 12/5/96 3:50 PM

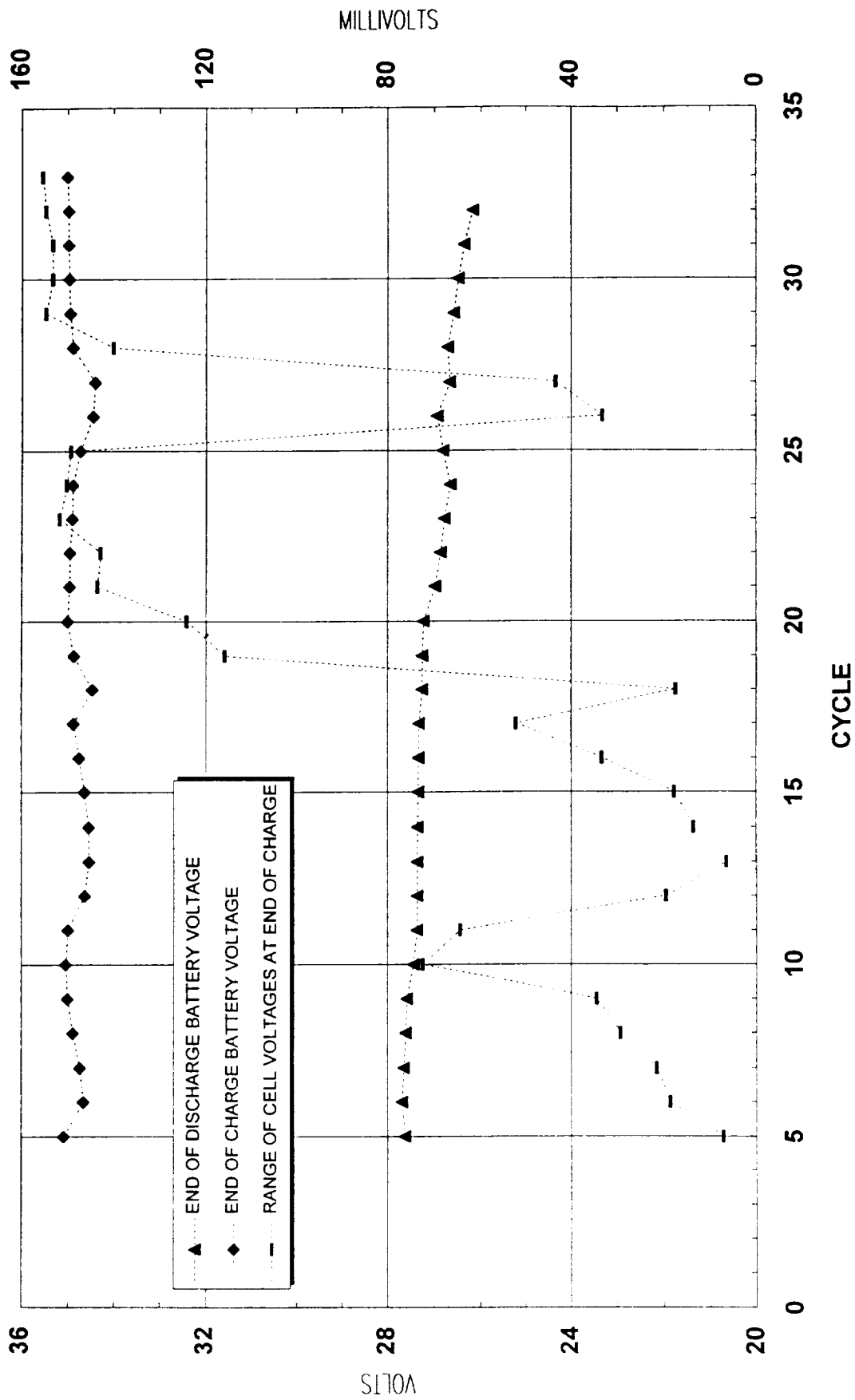
MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY
CYCLE #32 - CHARGE TO 1.950 VOLTS PER CELL THEN DISCHARGE AT 3.0A TO 20.0 AMP-HRS AT 15°C



MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY
CHARGE TO 1.950 VOLTS PER CELL THEN DISCHARGE AT 3.0A TO 20.0 AMPERE-HOURS



**MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY
CHARGE TO 1.950 VOLTS PER CELL THEN DISCHARGE AT 3.0A TO 20.0 AMPERE-HOURS**



MARS PATHFINDER -- BST 18 CELL, 40 AMPERE-HOUR, Ag-Zn SIMULATION BATTERY
CHARGE TO 1.950 VOLTS PER CELL THEN DISCHARGE AT 3.0A TO 20.0 AMPERE-HOURS



D. PERRONE 12/5/96 3:49 PM

Mars Pathfinder Battery - Conclusions

- Battery survived 47 days at 25°C and supported launch loads
- Battery survived a 7 month stand at 10 to -5°C
- Battery met and exceeded 40 ampere-hour capacity for EDL
- Battery met the 30 cycle minimum for Mars surface operation
- The projected power profile for Mars surface operation does not yield energy balance

Acknowledgment

- This work was performed at the Jet Propulsion Laboratory, California Institute of Technology under contract with the National Aeronautic and Space Administration.
- This work was sponsored by the Mars Pathfinder Project and the NASA office of the Chief Engineer (Code AE)
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- Thanks to Steve Dawson, Mike Shirbacheh, Burton Otzinger, and Subbarao Surampudi of JPL.

